

**UPDATE ON *AEQUIPECTEN OPERCULARIS* STOCK STATUS AND
RECOMMENDED TOTAL ALLOWABLE CATCH**



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Third Draft

26th July 2010

INTRODUCTION

In this document data from the most recent survey conducted around the Isle of Man is presented. These data form part of the time-series derived from biannual surveys undertaken since 1992 (Figure 1). Queen scallop, *Aequipecten opercularis*, landings data from the past three years are also presented. A Total Allowable Catch (TAC) is recommended for the queen scallop fishery for 2010/2011 developing the precautionary approach to setting the TAC as described in Murray *et al.* (2009b). It is important to note that this TAC cannot be implemented until appropriate legislation is in place.

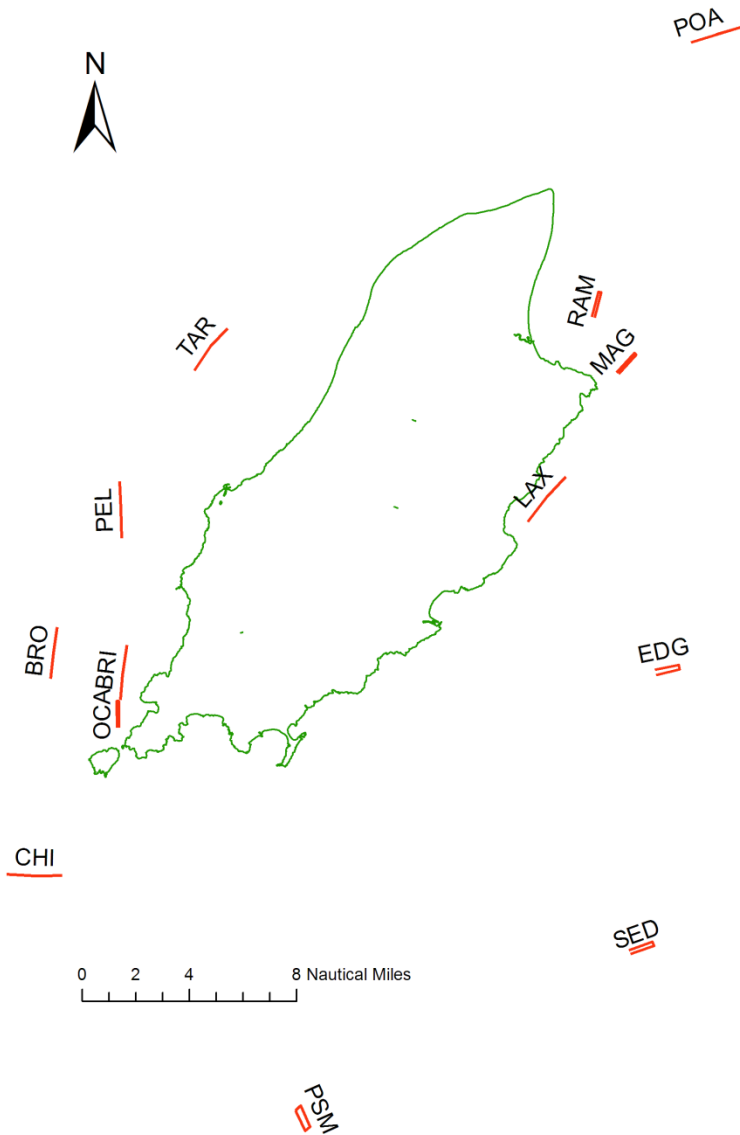


Figure 1. Stations surveyed around the Isle of Man since 1992. NB: Not all stations have been surveyed every year. Bradda Inshore (BRI), Bradda Offshore (BRO), Outside Closed Area (OCA), Chickens (CHI), Peel (PEL), Port St Mary (PSM), East of Douglas (EDG), South East of Douglas (SED), Laxey (LAX), Maughold (MAG), Ramsey (RAM), Point of Ayre (POA) and Targets (TAR).

A simple and precautionary strategy has been adopted to help ensure that *A. opercularis* stocks within the Isle of Man's territorial waters are not over-exploited. In the absence of data on queen scallops under c.50 mm in size (these smaller scallops are under-sampled) it is not possible to forecast recruitment to the fishery with any certainty. However, by using the long-term biannual survey data a TAC is recommended with the aim of ensuring that stock size continues to increase in size. Given uncertainty about whether vessels are fishing within or outside the Isle of Man's territorial waters, and the current spatial resolution of catch data, the TAC is set for ICES statistical rectangles 36E5 and 37E5. It is suggested that once the TAC is reached that the fishery is closed within the Isle of Man's territorial waters. Clearly this would not prevent fishing continuing outside the territorial sea. However, any excess landings within 36E5 and 37E5 could then be subtracted from the subsequent year's TAC (Figure 2). In addition, any landings reported late, after the TAC is set, should also be subtracted from the following year's TAC. Once electronic catch logging systems are in place it will be possible to set and implement a TAC specific to the territorial sea; this system is due to be active by July 2011.

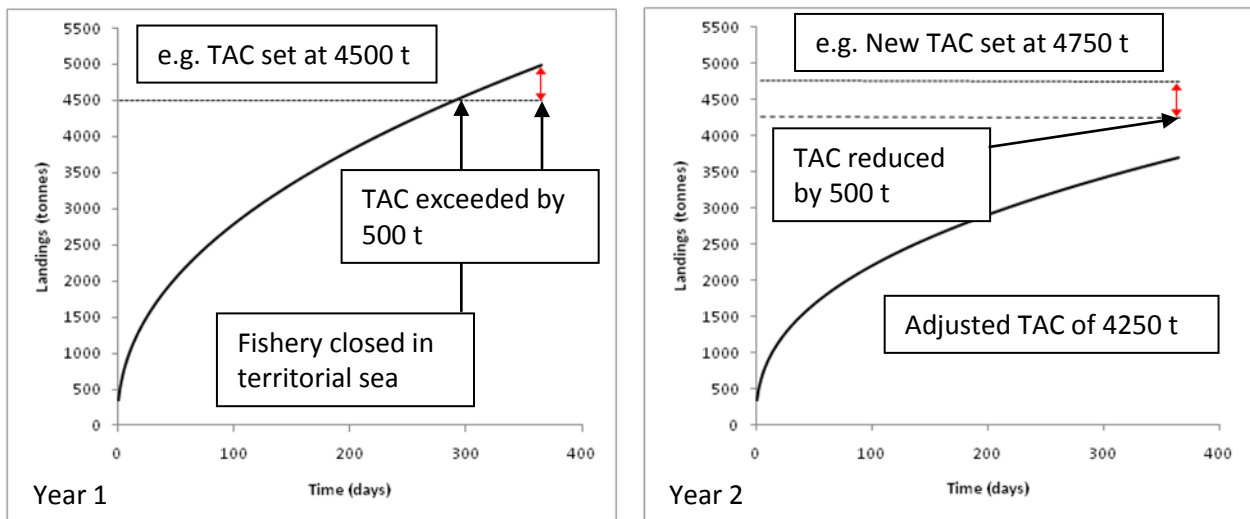


Figure 2. Schematic example of process of setting TAC. Solid line indicates cumulative landings, dotted line is TAC derived from survey abundance index and landings in previous three years, and dashed line is the TAC adjusted for over-fishing in the previous year.

ABUNDANCE INDEX

Surveys have been conducted in June and October each year since 1992. These surveys were designed to assess *Pecten maximus* stocks; however, *A. opercularis* are also caught in the queen scallop dredges used. Further details of the survey methodology are presented in Murray *et al.* (2009a). The abundance index derived from the June survey is considered to be the better indicator of recruitment to the fishery (Vause *et al.*, 2007) as most queen scallop fishing occurs during the closed season for the *Pecten maximus* fishery, from June to October. Therefore, at this time the survey abundance index will be less dependent on the removal of queen scallops in the preceding months. The higher variability observed in abundance in October than in June (Figure 3) is probably due in part to the different levels of exploitation. Sampling during 2008, 2009 and 2010 has included more survey sites than in previous years. Increasing the number of survey sites will provide a more representative sample of queen scallop stock. It is hoped that an index derived from a broader range of stations surveyed using a random sampling design will replace the existing index.

The June abundance index has shown a continued increase from only 2 individuals 100m^{-2} in 1992, while October abundance has increased from 9 ind. 100m^{-2} in 1992. The most plausible explanation for this low abundance is over-fishing prior to 1992. Total landings to Scotland and the Isle of Man in 1972 exceeded 7600 tonnes and in 1972 were over 5700 tonnes, another peak in landings, of 5600 tonnes, occurred in 1983. Mean landings from 1992 to 2006 were 2290 tonnes, compared to 3979 tonnes from 2007 to 2009. Mean landings to Scotland and the Isle of Man from ICES statistical rectangles 36E5 and 37E5 before the survey period were 4081 tonnes. From 2008 to 2010 the June abundance index increased from 12.5 ± 5.4 (2008) to 15.5 ± 5.7 (2009) to 17.3 ± 5.5 ind. 100m^{-2} (2010) across five sites commonly fished for queen scallops (CHI, LAX, PSM, SED, TAR).

There has been an exponential increase in queen scallop abundance based on the density at the four regular survey stations (LAX, EDG, PSM, CHI), with a particularly sharp rise in abundance during 2009. Given this increase, it is unrealistic to expect this relationship to continue. The predicted June abundance was 25 ind. 100m^{-2} compared to an actual value of 18 ind. 100m^{-2} . However, this value falls within the predicted lower 95% confidence interval of 15 ind. 100m^{-2} . There was a particularly large increase in abundance at Point of Ayre, and a smaller increase at South East of Douglas (Figure 4). Of the survey stations visited in each of the past three years there has been an increase in queen scallop abundance at the South East of Douglas survey station and a decrease at Chickens (Figure 5).

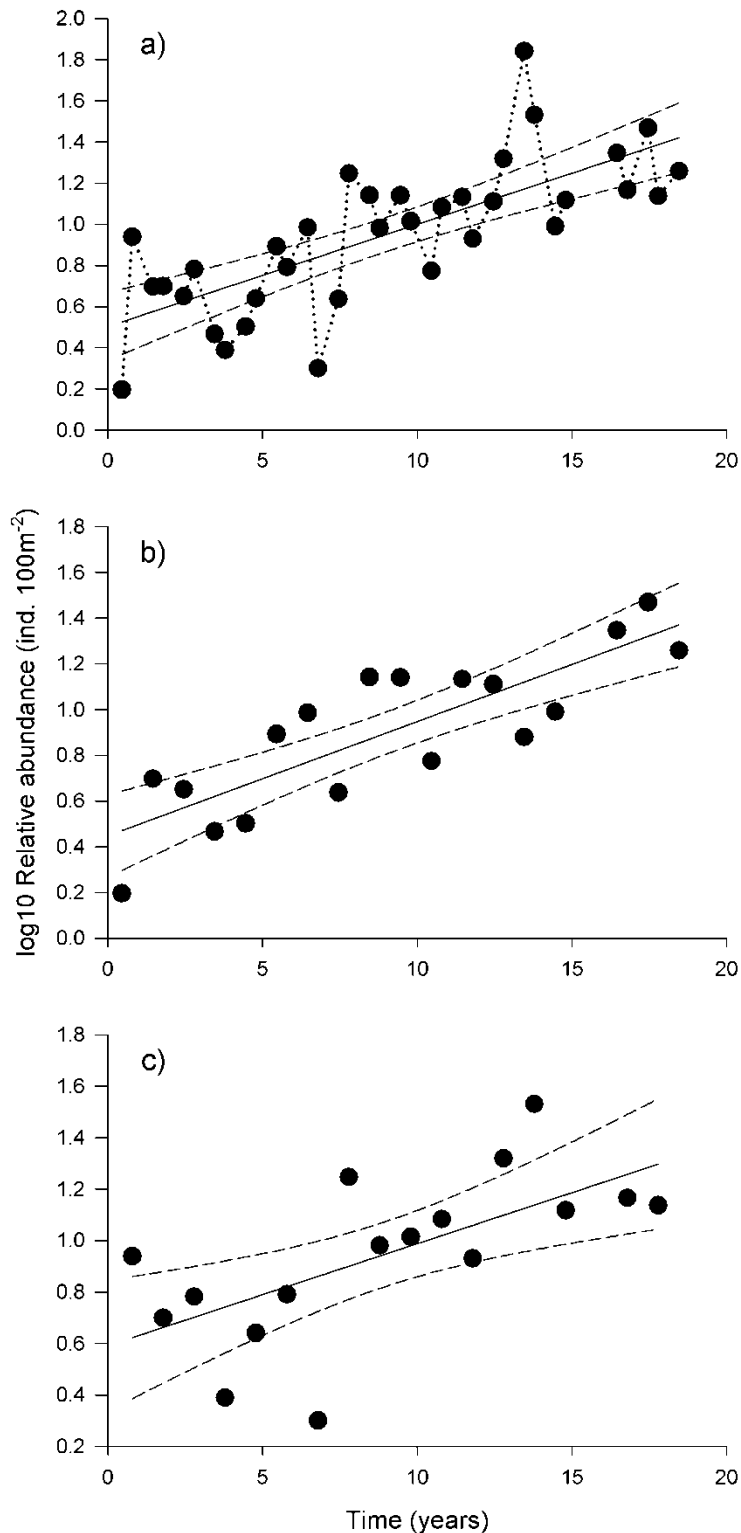


Figure 3. Relationship between time and a) all data from June 1992 onwards ($y = 0.05x + 0.504$, $R^2 = 0.547$, $p < 0.0001$) b) June data only ($y = 0.050x + 0.447$, $R^2 = 0.697$, $p < 0.0001$) and c) October data only ($y = 0.040x + 0.592$, $R^2 = 0.421$, $p < 0.005$). NB: exceptionally high value from Laxey in June 2005 (121 individuals 100m⁻²) has been excluded (b).

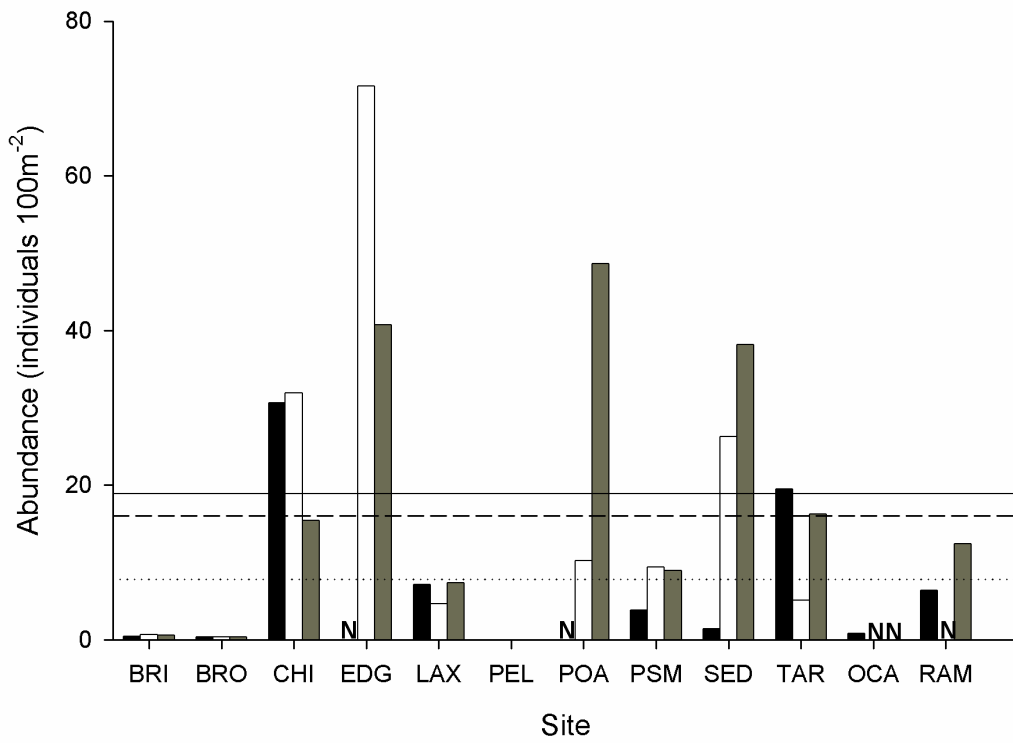


Figure 4. Mean abundance of *Aequipecten opercularis* at all sites surveyed in June 2008 (solid bars), June 2009 (open bars) and June 2010 (grey bars). Horizontal lines show mean across all sites surveyed (excluding Peel) in June 2008 (dotted), June 2009 (dashed) and June 2010 (solid). N = No sample.

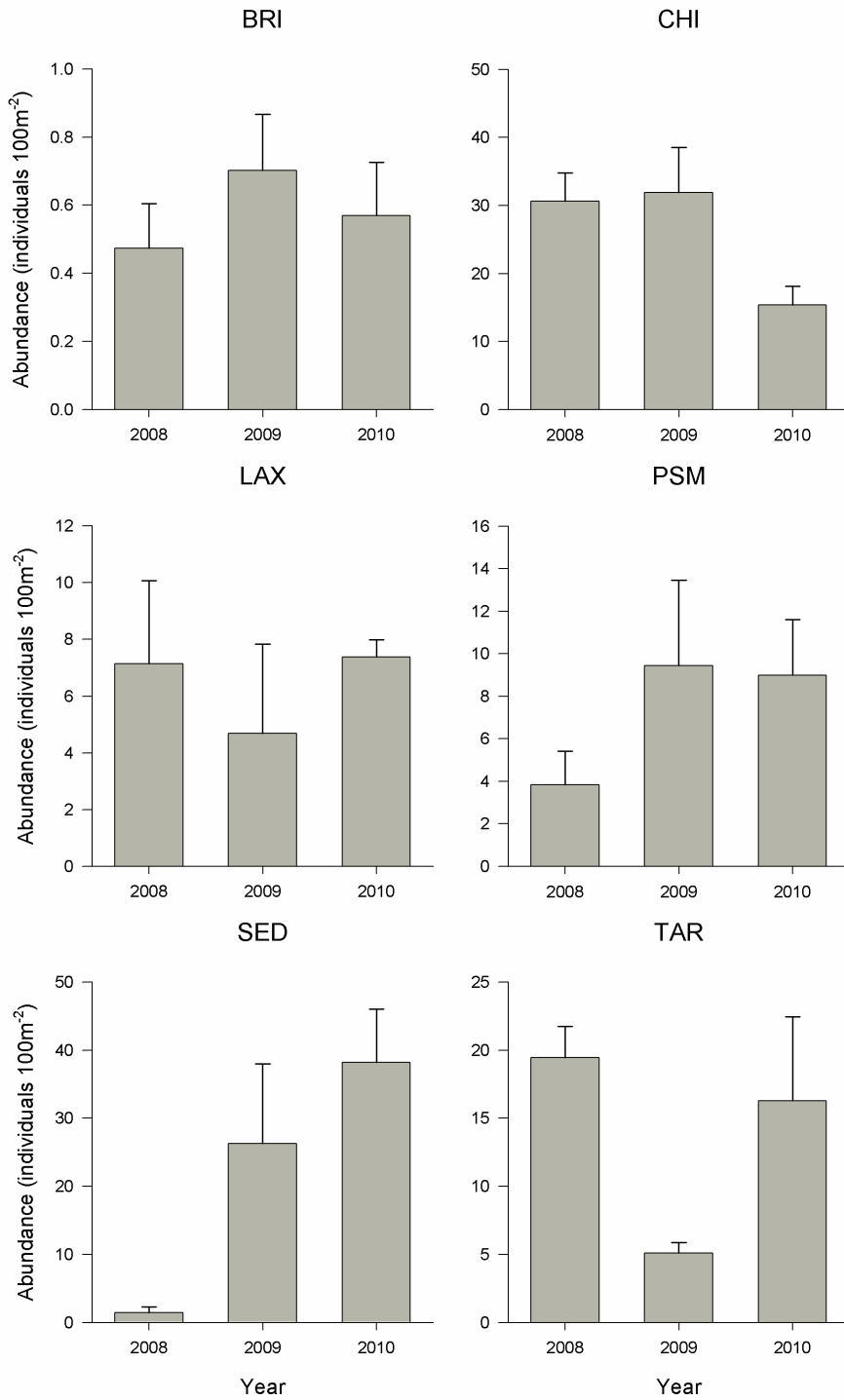


Figure 5. Mean abundance (+1 SE) of queen scallops at each of six stations surveyed in June 2008, 2009 and 2010.

RECENT LANDINGS

Landings of queen scallops from ICES statistical rectangles 36E5 and 37E5 have remained relatively stable during the past three years; however, there was a decline in landings to the Isle of Man during 2008 (Table 1). The majority of landings originate from Scottish vessels landing to Scottish ports (Tables 2 and 3). Manx vessels landings to Manx ports constitute the next largest component of the fishery in this area. There are also some landings by Northern Irish and Welsh vessels to English, Welsh and Northern Irish Ports (Tables 2 and 3). Combined landings to Scotland and the Isle of Man in 2009 were at an 11 year high, of 3888 tonnes. Given this recent large increase in landings, it is not recommended that landings increase any further over the next year.

Table 1. Landings into the Isle of Man and UK, and total landings of *Aequipecten opercularis* caught in ICES statistical rectangles 36E5 and 37E5.

Year	Landings to IOM (tonnes)	Landings to UK (tonnes)	Total Landings (tonnes)
2007	1444	2353	3797
2008	638	3138	3776
2009	1139	3225	4364

Table 2. UK landings (tonnes), by vessel nationality, of *Aequipecten opercularis* caught in ICES statistical rectangles 36E5 and 37E5 from 2007 to 2009.

Vessel nationality	2007		2008		2009		Total
	36E5	37E5	36E5	37E5	36E5	37E5	
Belgium	3.97		0.09				4.06
Isle of Man		456.58		199.81		229.38	885.77
Northern Ireland	16.12	61.59					77.71
Scotland	464.00	1292.81	1100.80	1836.76	610.33	2087.86	7392.57
Wales		57.81				297.42	355.22
Total	484.09	1868.79	1100.89	2036.57	610.33	2614.66	

Table 3. UK landings (tonnes), by port, of *Aequipecten opercularis* caught in ICES statistical rectangles 36E5 and 37E5 from 2007 and 2009.

Landing port	2007		2008		2009		Total
	36E5	37E5	36E5	37E5	36E5	37E5	
Campbeltown						0.03	0.03
Holyhead		57.81	20.43			330.66	408.90
Isle Of Whithorn		527.29		304.50		229.38	1061.18
Kilkeel	16.12	61.59					77.71
Kirkcudbright	396.92	1222.10	1080.37	1729.44	465.14	2054.59	6948.56
Liverpool	23.52		0.09		145.18		168.80
Troon and Saltcoats				2.63			2.63
Whitehaven	47.53						47.53
Total	484.09	1868.79	1100.89	2036.57	610.33	2614.66	

SETTING THE TAC

The proposed schedule for data collection, monitoring of landings and implementing the TAC is given in Table 4. This schedule depends on the continuation of annual surveys and obtaining accurate landings data. The three year mean of landings from 36E5 and 37E5 will be used as the measure of current levels of exploitation. From 2007 to 2009 this stands at 3979 tonnes. At present, the weight of landings in the Isle of Man is estimated from the number of bags landed and nominal bag weights, usually of 36 to 40 kg. However, bags are now weighed in the Isle of Man's processing factory and these data delivered to DEFA. Any consistent difference in reported weight of landings resulting from this change must be accounted for when assessing when the TAC is reached.

The queen scallop fishery depends largely upon the two-year-olds recruiting to the fishery and to a lesser extent three-year-olds (Vause *et al.*, 2007). The number of scallops recruiting to the fishery will also depend on spawning stock biomass and success. Thus, the biomass available for exploitation in 2010 will have been determined by recruitment success in the same year and spawning success in 2008. Spawning success in 2008 will have been determined by spawning stock biomass following the 2007 fishing season. Spawning stock biomass varies as a function of fishing mortality, natural mortality and growth rates. Therefore, landings from 2007 to 2009 will have had a direct impact on the abundance index in 2010.

One approach would be to allow an increase in TAC only if the abundance index increases above the upper 95% confidence interval, as long as there is a positive relationship between time and abundance. However, as the abundance index is derived from four sites only, additional information would be ignored. Therefore, the mean 95% confidence interval about the relationship between time and scallop abundance will be used as the threshold boundaries, which will result in an increase or decrease in TAC, but will be applied to all available data. The relationship between time (years from January 1992) and queen scallop abundance (not logged) was described by the relationship $y = ae^{bx}$ ($F_{1,16} = 34.67$, $R^2 = 0.68$, $p < 0.0001$), where y = abundance, x = time, and a and b are constants 3.395 and 0.105, respectively. At the extreme the 95% confidence interval was ± 5.83 ind. 100 m^{-2} , while the mean 95% confidence interval was ± 2.87 ind. 100 m^{-2} . Thus, as a precautionary measure the abundance index must fall within 2.87 of the previous year's index for landings to be maintained at the present level. An abundance index > 2.87 above the previous year's value will allow a proportional increase in TAC, and an index > 2.87 below the previous year's value will trigger a proportional decrease. The cumulative change in abundance over more than one year will be used to determine any adjustment of the TAC following a period of no change to allow for adjustment of the TAC with small annual changes in abundance (≤ 2.87 ind. $100\text{ m}^{-2}\text{ y}^{-1}$) in consecutive years. The mean queen scallop abundance at the seven commercially fished survey sites (CHI, POA, PSM, LAX, EDG, SED, TAR. BRI and BRO have not been included) surveyed in both June 2009 and June 2010 was 22.75 and 25.09 ind. 100 m^{-2} in those two years, respectively, a difference of 2.34. Therefore, a TAC of 3979 tonnes is recommended for the period between 1st June 2010 and 31st May 2011 to reduce the risk of the Isle of Man's queen scallop populations being over-exploited.

Table 4. Example of process of setting, monitoring and implementing the Total Allowable Catch (TAC).

Time	Activity
1 st June 2010 to 31 st May 2011*	DEFA obtain data from fishers and MMO. Landings data entry
June 2010	DEFA release landings data for June 2009 to May 2010
June 2010	Queen scallop stock survey by scientific team
June/July 2010	Scientific data entry and analysis
July 2010	Scientific advice on level of TAC between June '10 and May '11
July/August 2010	DEFA set TAC for 1 st June 2010 to 31 st May 2011
June 2010 – May 2011	Fishery closed at any time if TAC reached

*NB. At present landings are collated on an annual basis from January to December and the TAC given in this report is based on this value.

CONCLUSIONS AND FUTURE DEVELOPMENTS

The queen scallop fishery in the Isle of Man's territorial sea is managed predominantly by the Isle of Man Government. However, only data on landings to the Isle of Man, and by Manx vessels to the UK, is obtained at present. Only total annual UK landings data spatially referenced to ICES statistical rectangles can be obtained from the Marine Management Organisation (MMO). Therefore, it is not possible to distinguish between catches from within the territorial sea and those from outside. Consequently, it will not be possible to know when a TAC set for the territorial sea is reached.

Present levels of exploitation are allowing an increase in queen scallop stock size. The aim of setting this TAC is to maintain the increase in queen scallop abundance and thereafter maintain abundance at a steady level. It is important to note that the size of the queen scallop stocks may be dependent on stocks both within and outside of the Isle of Man's territorial waters. It may be possible to counteract the effects of over-exploitation outside of the territorial sea on stocks within the territorial sea by reducing landings in the Isle of Man fishery. This would prove detrimental to the value of the Isle of Man fishery and would not represent a long-term solution. McLeod (1984) identified temporal variation in the source of recruitment to the Isle of Man queen scallop fishery, and that larvae from outside the Isle of Man's queen scallop beds can contribute to the local populations, probably due to variation in hydrographic conditions between years. However, Lewis and Thorpe (1994) found that queen scallops from different sites around the Isle of Man are genetically dissimilar and suggest that *A. opercularis* populations may be self-recruiting. Therefore, there is still uncertainty about the sources of larvae settling in the Isle of Man's territorial waters, although it seems likely that both local and more distant spawning stocks contribute. It is important to note that the increase in queen scallop abundance has occurred during a period where exploitation of the stock has been relatively light. It must not be assumed that landings can increase in magnitude indefinitely without having a detrimental effect on queen scallop stocks.

It is imperative that a means of sampling smaller queen scallops is developed; this will allow a recruitment index to be derived and forecasts of recruitment to the fishery made. The present approach, which derives a TAC from an abundance index of larger animals only, is necessarily more precautionary. Consistency in the range of sites surveyed each year will help to distinguish between temporal and spatial variability in abundance. The use of a random sampling approach within predefined survey areas will also improve confidence that the abundance index is representative of the wider population size. Specific objectives for future research are:

1. Development of a recruitment index through improved sampling of queen scallops <50 mm. Dredge trials will begin in October 2010 at the earliest or June 2011 at the latest.
2. Development of a random sampling protocol to ensure the abundance index is representative of the wider population. This new sampling methodology will be conducted alongside the existing survey methodology from June 2011.
3. Peer-review of stock assessment. It is proposed that this is achieved through the establishment of a British Isles scallop working group whereby research can be presented, reviewed and published in an annual report. This group would be established by April 2011.
4. A more formal stock assessment process will be adopted by 2014. Research will aim to derive biomass estimates and a maximum sustainable yield for the fishery.

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